

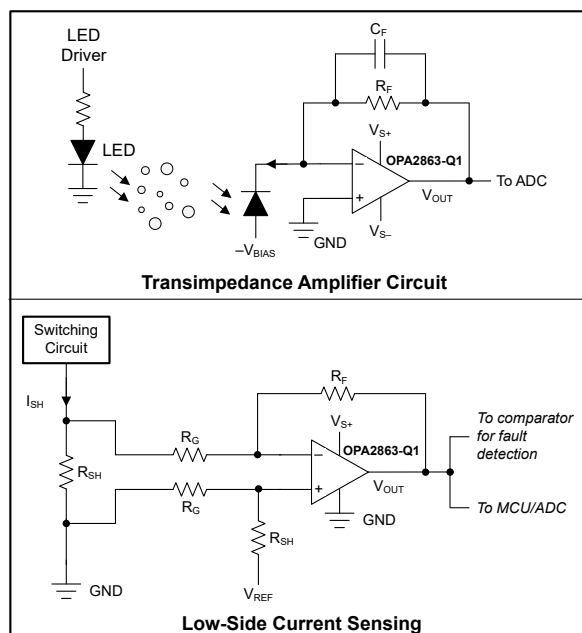
# OPA2863-Q1 汽车类、低功耗、110MHz、轨到轨输入/输出放大器

## 1 特性

- 符合面向汽车应用的 AEC-Q100 标准：
  - 温度等级 1：-40°C 至 +125°C，T<sub>A</sub>
- 宽带宽
  - 单位增益带宽：110MHz
  - 增益带宽积：50MHz
- 低功耗
  - 静态电流：700μA/通道（典型值）
  - 电源电压：2.7V 至 12.6V
- 输入电压噪声：5.9nV/√Hz
- 压摆率：105V/μs
- 轨到轨输入和输出
- HD<sub>2</sub>/HD<sub>3</sub>：在 20 kHz (2V<sub>PP</sub>) 时为 -129dBc/-138dBc
- 其他特性：
  - 过载功率限制
  - 输出短路保护

## 2 应用

- 低侧电流检测
- 直流/直流转换器
- 逆变器和电机控制
- 车载充电器和无线充电器
- HVAC 压缩机
- 光电二极管 TIA 接口
- 抬头显示 (HUD)



使用以下器件的应用电路：OPA2863-Q1

## 3 说明

OPA2863-Q1 是单位增益稳定的低功耗、轨到轨输入/输出、电压反馈运算放大器，旨在 2.7V 至 12.6V 的电源电压范围内运行。OPA2863-Q1 每通道仅消耗 700μA 的电流，提供的增益带宽积为 50MHz，压摆率为 105V/μs，电压噪声密度为 5.9nV/√Hz。

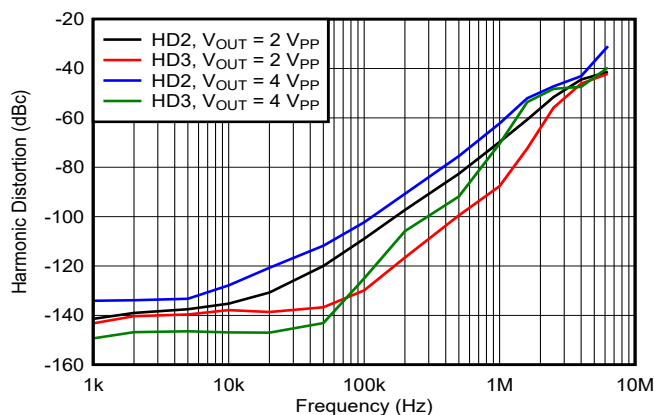
轨到轨输入级使得 OPA2863-Q1 非常适合电流检测和光电二极管接口等通用应用。轨到轨输入级可在整个输入共模电压范围内很好地匹配增益带宽积和噪声，从而在宽输入动态范围内实现出色的性能。

OPA2863-Q1 包括过载功率限制功能，可限制输出饱和时 I<sub>Q</sub> 的增加，从而避免电池供电的功率敏感型系统中出现过度功率耗散。输出级具有短路保护功能，使得此类器件可适应恶劣的环境。

### 封装信息

器件型号 <sup>(1)</sup>	封装 <sup>(2)</sup>	封装尺寸 <sup>(3)</sup>
OPA2863-Q1	D (SOIC, 8)	4.9 mm × 6 mm

- 有关相关产品，请参阅 [器件比较表](#)。
- 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。
- 封装尺寸（长 × 宽）为标称值，并包括引脚（如适用）。



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## 4 Revision History

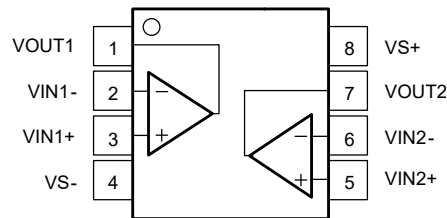
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Changes from Revision * (February 2023) to Revision A (July 2023)	Page
• 将数据表状态从“预告信息（预发布）”更改为“量产数据（正在供货）”.....	1

## 5 Device Comparison Table

DEVICE	$\pm V_S$ (V)	$I_Q$ /CHANNEL (mA)	GBWP (MHz)	SLEW RATE (V/ $\mu$ s)	VOLTAGE NOISE (nV/ $\sqrt{\text{Hz}}$ )	AMPLIFIER DESCRIPTION
<a href="#">OPA2863-Q1</a>	$\pm 6.3$	0.70	50	105	5.9	Unity-gain-stable. RRIO bipolar amplifier
<a href="#">OPA2365-Q1</a>	$\pm 2.75$	4.6	50	25	4.5	Unity-gain-stable, zero-crossover, RRIO CMOS amplifier
<a href="#">OPA2607-Q1</a>	$\pm 2.75$	0.9	50	24	3.8	Gain of 6 V/V stable, NRI/RRO CMOS amplifier
<a href="#">OPA2836-Q1</a>	$\pm 2.75$	1	110	560	4.6	Unity-gain stable, low-power, NRI/RRO bipolar amplifier

## 6 Pin Configuration and Functions



**图 6-1. D Package,  
8-Pin SOIC  
(Top View)**

**表 6-1. Pin Functions**

PIN		TYPE <sup>(1)</sup>	DESCRIPTION
NAME	NO.		
VIN1 -	2	I	Amplifier 1 inverting input pin
VIN1+	3	I	Amplifier 1 noninverting input pin
VIN2 -	6	I	Amplifier 2 inverting input pin
VIN2+	5	I	Amplifier 2 noninverting input pin
VOUT1	1	O	Amplifier 1 output pin
VOUT2	7	O	Amplifier 2 output pin
VS -	4	P	Negative power-supply pin
VS+	8	P	Positive power-supply pin

(1) I = input, O = output, and P = power.

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
$V_{S-}$ to $V_{S+}$	Supply voltage		13	V
	Supply turn-on/off maximum dV/dt		1	V/ $\mu$ s
$V_I$	Input voltage	$V_{S-} - 0.5$	$V_{S+} + 0.5$	V
$V_{ID}$	Differential input voltage		$\pm 1$	V
$I_I$	Continuous input current <sup>(2)</sup>		$\pm 10$	mA
$I_O$	Continuous output current <sup>(3)</sup>		$\pm 30$	mA
	Continuous power dissipation	See <a href="#">Thermal Information</a>		
$T_J$	Junction temperature		150	$^{\circ}$ C
$T_A$	Operating ambient temperature	- 40	125	$^{\circ}$ C
$T_{stg}$	Storage temperature	- 65	150	$^{\circ}$ C

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) Continuous input current limit for both the ESD diodes to the supply pins and amplifier differential input clamp diode. The differential input clamp diodes limit the voltage between the two inputs to 1 V with this continuous input current flowing through these diodes.
- (3) Long-term continuous current for electromigration limits.

### 7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 <sup>(1)</sup> HBM ESD classification level 2	$\pm 2000$	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD classification level C6	$\pm 1000$	

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with ANSI/ESDA/JEDEC JS-001 specification.

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
$V_{S+} - V_{S-}$	Total supply voltage	2.7	10	12.6	V
$T_A$	Ambient temperature	- 40	25	125	$^{\circ}$ C

### 7.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		OPA2863-Q1	UNIT
		D (SOIC)	
		8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	120.0	$^{\circ}$ C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	63.3	$^{\circ}$ C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	63.2	$^{\circ}$ C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	17.2	$^{\circ}$ C/W
$Y_{JB}$	Junction-to-board characterization parameter	62.5	$^{\circ}$ C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 7.5 Electrical Characteristics: $V_S = \pm 5\text{ V}$

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output common-mode is at mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>AC PERFORMANCE</b>						
SSBW	Small-signal bandwidth	$V_{OUT} = 20\text{ mV}_{PP}$ , $G = 1$		110		MHz
GBWP	Gain-bandwidth product			50		MHz
LSBW	Large-signal bandwidth	$V_{OUT} = 2\text{ V}_{PP}$		17		MHz
	Bandwidth for 0.1-dB flatness	$V_{OUT} = 20\text{ mV}_{PP}$		15		MHz
SR	Slew rate	$V_{OUT} = 2\text{-V step}$ , $G = -1$		105		V/ $\mu\text{s}$
	Rise, fall time	$V_{OUT} = 200\text{-mV step}$		9		ns
	Settling time	To 0.1%, $V_{OUT} = 2\text{-V step}$		57		ns
		To 0.01%, $V_{OUT} = 2\text{-V step}$		70		
	Overshoot/undershoot	$V_{OUT} = 2\text{-V step}$		1		%
	Overdrive recovery time	$G = -1$ , 0.5-V overdrive beyond supplies		70		ns
		$G = 1$ , 0.5-V overdrive beyond supplies		100		
HD2	Second-order harmonic distortion	$f = 20\text{ kHz}$ , $V_{OUT} = 2\text{ V}_{PP}$		-129		dBc
HD3	Third-order harmonic distortion	$f = 20\text{ kHz}$ , $V_{OUT} = 2\text{ V}_{PP}$		-138		dBc
HD2	Second-order harmonic distortion	$f = 100\text{ kHz}$ , $V_{OUT} = 2\text{ V}_{PP}$		-107		dBc
HD3	Third-order harmonic distortion	$f = 100\text{ kHz}$ , $V_{OUT} = 2\text{ V}_{PP}$		-125		dBc
$e_N$	Input voltage noise	1/f corner at 25 Hz		5.9		nV/ $\sqrt{\text{Hz}}$
$i_N$	Input current noise	1/f corner at 2 kHz		0.4		pA/ $\sqrt{\text{Hz}}$
	Closed-loop output impedance	$f = 1\text{ MHz}$		0.2		$\Omega$
	Channel-to-channel crosstalk	$f = 1\text{ MHz}$ , $V_{OUT} = 2\text{ V}_{PP}$		-124		dBc
<b>DC PERFORMANCE</b>						
$A_{OL}$	Open-loop voltage gain	$V_{OUT} = \pm 2.5\text{ V}$	110	128		dB
$V_{OS}$	Input-referred offset voltage		-1.5	$\pm 0.4$	1.5	mV
	Input offset voltage drift	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	-4	$\pm 1$	4	$\mu\text{V}/^\circ\text{C}$
	Input bias current	$T_A \approx 25^\circ\text{C}$		0.3	0.73	$\mu\text{A}$
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			1.2	
		$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			1.6	
	Input bias current drift	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$\pm 3$	7.6	nA/ $^\circ\text{C}$
	Input offset current		-30	$\pm 10$	30	nA
<b>INPUT</b>						
	Input common-mode voltage		$V_{S-} - 0.2$		$V_{S+} + 0.2$	V
CMRR	Common-mode rejection ratio	$V_{CM} = V_{S-} - 0.2\text{ V}$ to $V_{S+} - 1.6\text{ V}$	100	120		dB
	Input impedance common-mode			650    0.8		M $\Omega$    pF
	Input impedance differential mode			200    0.5		k $\Omega$    pF
<b>OUTPUT</b>						
$V_{OL}$	Output voltage, low	$T_A \approx 25^\circ\text{C}$		$V_{S-} + 0.14$	$V_{S-} + 0.2$	V
		$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$V_{S-} + 0.15$	$V_{S-} + 0.22$	
$V_{OH}$	Output voltage, high	$T_A \approx 25^\circ\text{C}$	$V_{S+} - 0.2$	$V_{S+} - 0.14$		V
		$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	$V_{S+} - 0.2$	$V_{S+} - 0.15$		
	Linear output drive (sourcing and sinking)	$V_{OUT} = \pm 2.5\text{ V}$ , $\Delta V_{OS} < 1\text{ mV}^{(1)}$	25	30		mA
	Short-circuit current			45		mA

## 7.5 Electrical Characteristics: $V_S = \pm 5\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output common-mode is at mid-supply, and  $T_A \cong 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>POWER SUPPLY</b>						
$I_Q$	Quiescent current per amplifier	$T_A \cong 25^\circ\text{C}$		700	970	$\mu\text{A}$
		$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			1280	
PSRR	Power-supply rejection ratio	$\Delta V_S = \pm 2\text{ V}^{(2)}$	100	120		dB
<b>AUXILIARY INPUT STAGE</b>						
	Gain-bandwidth product			50		MHz
	Input voltage noise	1/f corner at 25 Hz		6		$\text{nV}/\sqrt{\text{Hz}}$
	Input current noise	1/f corner at 100 Hz		0.4		$\text{pA}/\sqrt{\text{Hz}}$
	Input-referred offset voltage		- 1.5	$\pm 0.15$	1.5	mV
	Input bias current	$T_A \cong 25^\circ\text{C}$		0.2	0.6	$\mu\text{A}$
		$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			1.3	
	Common-mode rejection ratio	$V_{CM} = 4.1\text{ V}$ to $5.2\text{ V}$	100	120		dB
	Power supply rejection ratio	$\Delta V_S = \pm 0.6\text{ V}$	100	120		dB

- (1) Change in input offset voltage from no-load condition.
- (2) Change in supply voltage from the default test condition with only one of the positive or negative supplies changing corresponding to +PSRR and - PSRR.

## 7.6 Electrical Characteristics: $V_S = 3\text{ V}$

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  connected to 1 V, input and output  $V_{CM} = 1\text{ V}$ , and  $T_A \cong 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>AC PERFORMANCE</b>						
SSBW	Small-signal bandwidth	$V_{OUT} = 20\text{ mV}_{PP}$ , $G = 1$		97		MHz
GBWP	Gain-bandwidth product			50		MHz
LSBW	Large-signal bandwidth	$V_{OUT} = 1\text{ V}_{PP}$		26		MHz
		Bandwidth for 0.1-dB flatness	$V_{OUT} = 20\text{ mV}_{PP}$	10		MHz
SR	Slew rate	$V_{OUT} = 1\text{-V}$ step, $G = -1$		105		$\text{V}/\mu\text{s}$
		Rise, fall time	$V_{OUT} = 200\text{-mV}$ step	10		ns
	Settling time	To 0.1%, $V_{OUT} = 1\text{-V}$ step		58		ns
		To 0.01%, $V_{OUT} = 1\text{-V}$ step		90		
	Overshoot	$V_{OUT} = 1\text{-V}$ step		2		%
	Undershoot	$V_{OUT} = 1\text{-V}$ step		16		%
	Overdrive recovery time	$G = -1$ , 0.5-V overdrive beyond supplies		95		ns
		$G = 1$ , 0.5-V overdrive beyond supplies		100		
HD2	Second-order harmonic distortion	$f = 20\text{ kHz}$ , $V_{OUT} = 1\text{ V}_{PP}$		- 123		dBc
HD3	Third-order harmonic distortion	$f = 20\text{ kHz}$ , $V_{OUT} = 1\text{ V}_{PP}$		- 132		dBc
HD2	Second-order harmonic distortion	$f = 100\text{ kHz}$ , $V_{OUT} = 1\text{ V}_{PP}$		- 109		dBc
HD3	Third-order harmonic distortion	$f = 100\text{ kHz}$ , $V_{OUT} = 1\text{ V}_{PP}$		- 129		dBc
$e_N$	Input voltage noise	1/f corner at 25 Hz		6		$\text{nV}/\sqrt{\text{Hz}}$
$i_N$	Input current noise	1/f corner at 2 kHz		0.4		$\text{pA}/\sqrt{\text{Hz}}$
	Closed-loop output impedance	$f = 1\text{ MHz}$		0.2		$\Omega$
	Channel-to-channel crosstalk	$f = 1\text{ MHz}$ , $V_{OUT} = 1\text{ V}_{PP}$		- 127		dBc

## 7.6 Electrical Characteristics: $V_S = 3\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  connected to  $1\text{ V}$ , input and output  $V_{CM} = 1\text{ V}$ , and  $T_A \cong 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>DC PERFORMANCE</b>						
$A_{OL}$	Open-loop voltage gain	$V_{OUT} = 1\text{ V to }2\text{ V}$	104	123		dB
$V_{OS}$	Input-referred offset voltage		- 1.5	$\pm 0.4$	1.5	mV
	Input offset voltage drift	$T_A = -40^\circ\text{C to }+125^\circ\text{C}$	- 4	$\pm 1$	4	$\mu\text{ V}/^\circ\text{C}$
	Input bias current	$T_A \cong 25^\circ\text{C}$		0.3	0.73	$\mu\text{ A}$
		$T_A = -40^\circ\text{C to }+85^\circ\text{C}$			1.2	
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$			1.6	
	Input bias current drift	$T_A = -40^\circ\text{C to }+125^\circ\text{C}$		$\pm 3$	7.4	$\text{nA}/^\circ\text{C}$
	Input offset current		- 30	$\pm 10$	30	nA
<b>INPUT</b>						
	Input common-mode voltage		$V_{S-} - 0.2$		$V_{S+} + 0.2$	V
CMRR	Common-mode rejection ratio	$V_{CM} = V_{S-} - 0.2\text{ V to }V_{S+} - 1.6\text{ V}$	94	115		dB
	Input impedance common-mode			$360\ \parallel\ 0.9$		$\text{M}\Omega\ \parallel\ \text{pF}$
	Input impedance differential mode			$200\ \parallel\ 0.5$		$\text{k}\Omega\ \parallel\ \text{pF}$
<b>OUTPUT</b>						
$V_{OL}$	Output voltage, low	$T_A \cong 25^\circ\text{C}$		$V_{S-} + 0.13$	$V_{S-} + 0.15$	V
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$		$V_{S-} + 0.13$	$V_{S-} + 0.16$	
$V_{OH}$	Output voltage, high	$T_A \cong 25^\circ\text{C}$	$V_{S+} - 0.15$	$V_{S+} - 0.13$		V
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$	$V_{S+} - 0.15$	$V_{S+} - 0.13$		
	Linear output drive (sourcing and sinking)	$V_{OUT} = \pm 0.7\text{ V}$ , $\Delta V_{OS} < 1\text{ mV}^{(1)}$	23	33		mA
	Short-circuit current			45		mA
<b>POWER SUPPLY</b>						
$I_Q$	Quiescent current per amplifier	$T_A \cong 25^\circ\text{C}$		690	910	$\mu\text{ A}$
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$			1180	
PSRR	Power-supply rejection ratio	$\Delta V_S = \pm 1\text{ V}^{(2)}$	100	120		dB
<b>AUXILIARY INPUT STAGE</b>						
	Gain-bandwidth product			50		MHz
	Input voltage noise	1/f corner at 25 Hz		6		$\text{nV}/\sqrt{\text{Hz}}$
	Input current noise	1/f corner at 100 Hz		0.4		$\text{pA}/\sqrt{\text{Hz}}$
	Input-referred offset voltage		- 1.5	$\pm 0.15$	1.5	mV
	Input bias current	$T_A \cong 25^\circ\text{C}$		0.2	0.6	$\mu\text{ A}$
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$			1.2	
	Common-mode rejection ratio	$V_{CM} = 2.1\text{ V to }3.2\text{ V}$	100	120		dB
	Power supply rejection ratio	$\Delta V_S = \pm 0.6\text{ V}$	100	115		dB

(1) Change in input offset voltage from no-load condition.

(2) Change in supply voltage from the default test condition with only one of the positive or negative supplies changing corresponding to +PSRR and - PSRR.

### 7.7 Typical Characteristics: $V_S = \pm 5\text{ V}$

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)

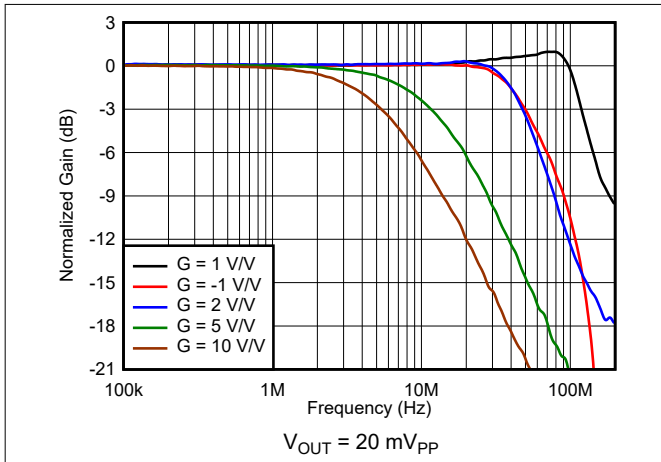


图 7-1. Small-Signal Frequency Response vs Gain

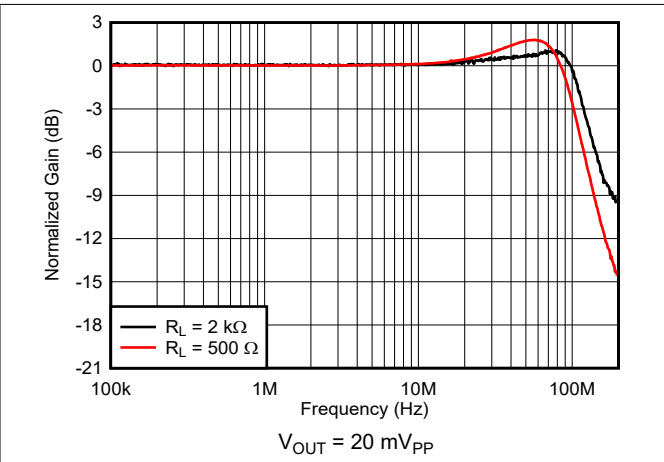


图 7-2. Small-Signal Frequency Response vs Output Load

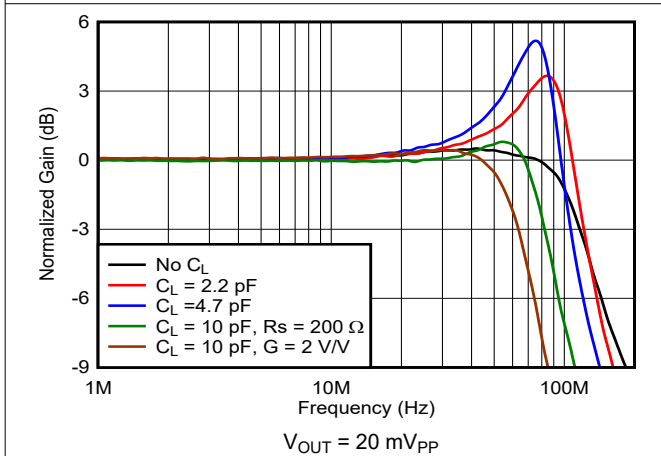


图 7-3. Frequency Response vs Load Capacitance

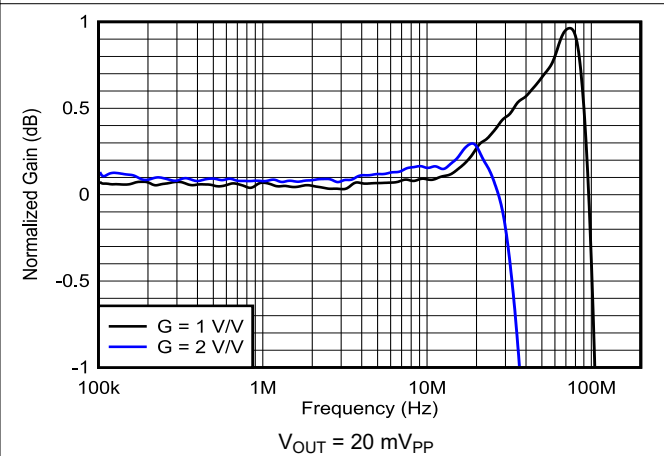


图 7-4. Small-Signal Response Flatness vs Gain

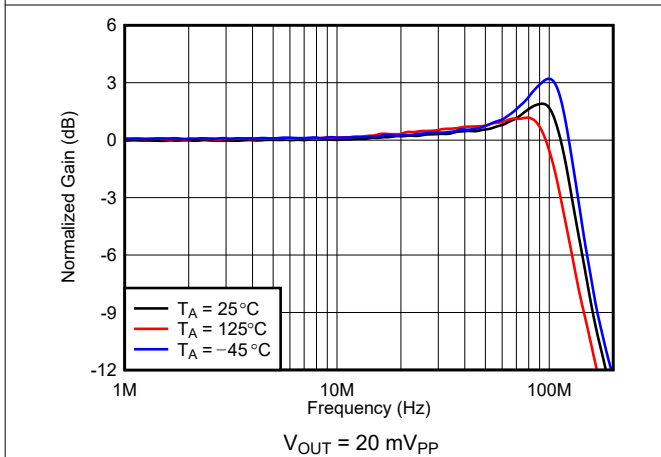


图 7-5. Frequency Response vs Ambient Temperature

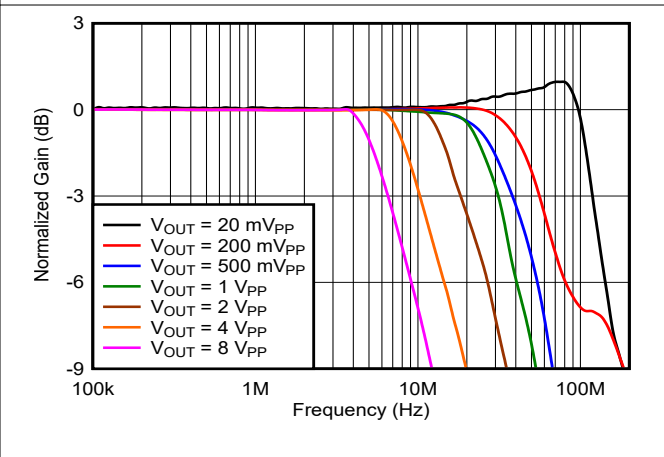
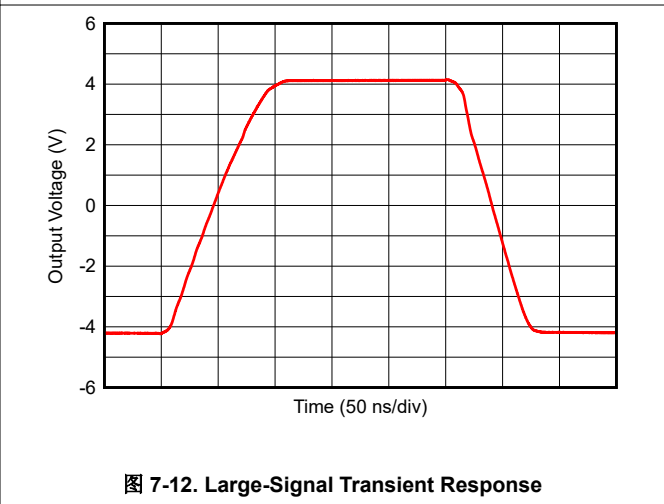
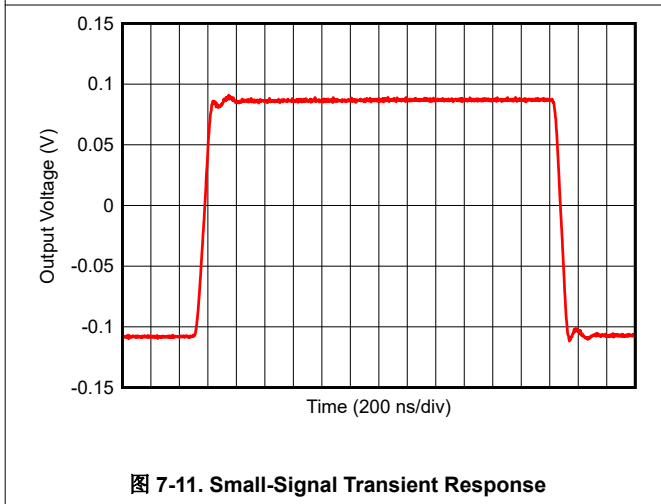
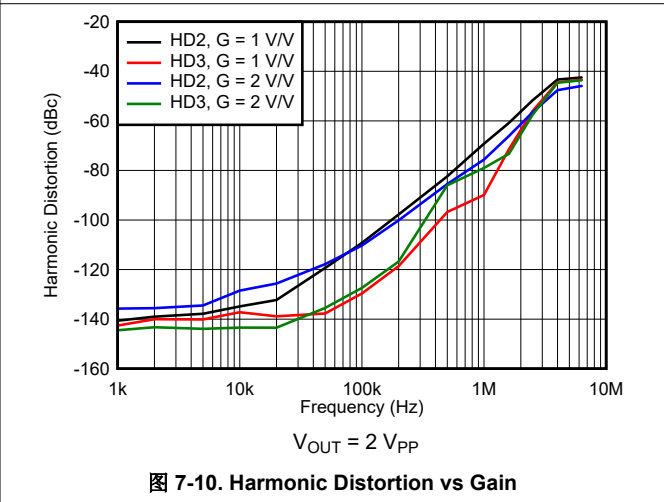
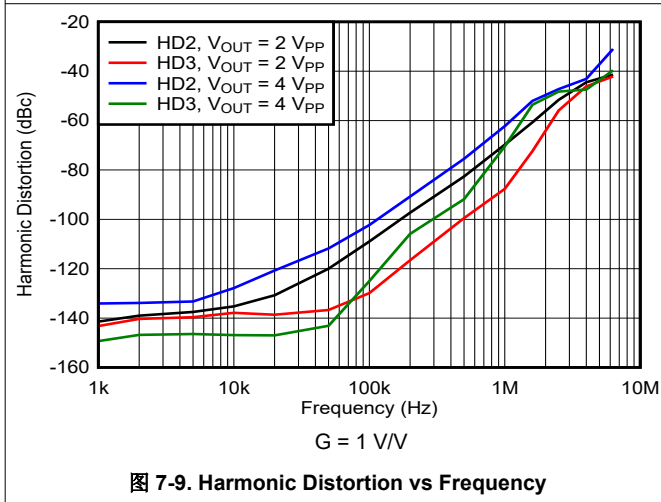
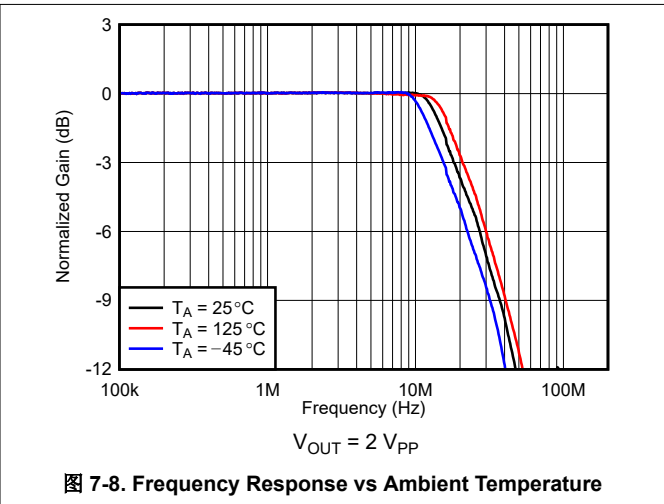
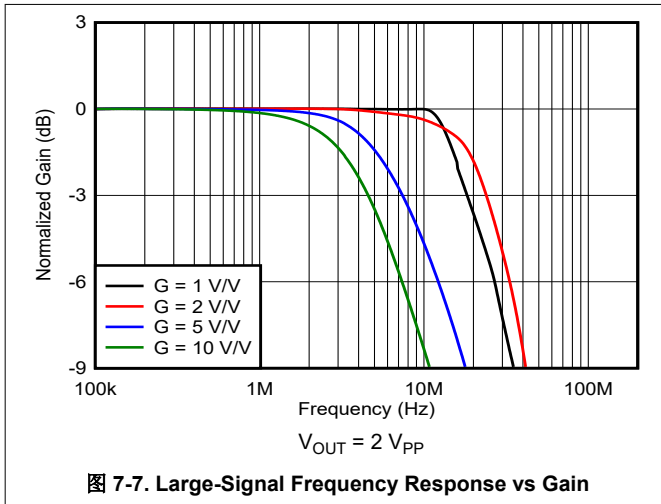


图 7-6. Frequency Response vs Output Voltage



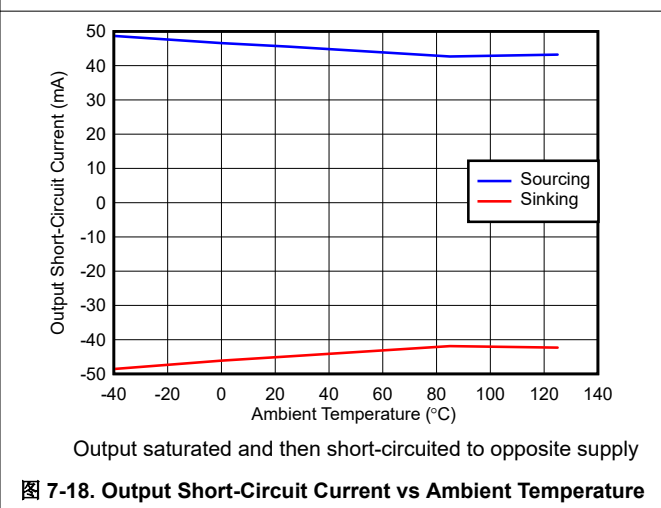
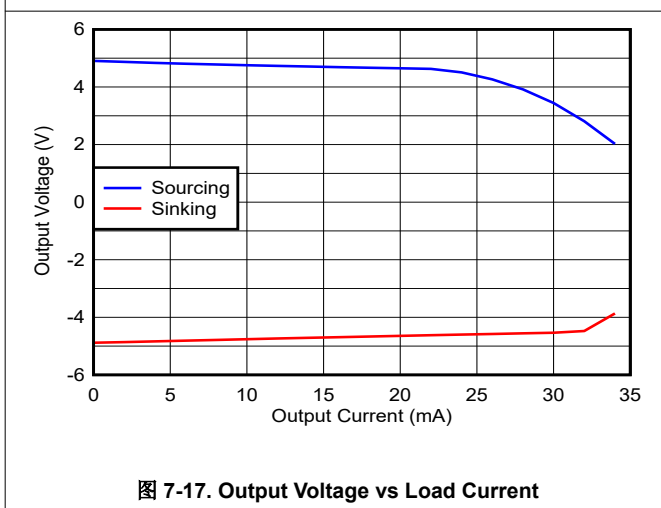
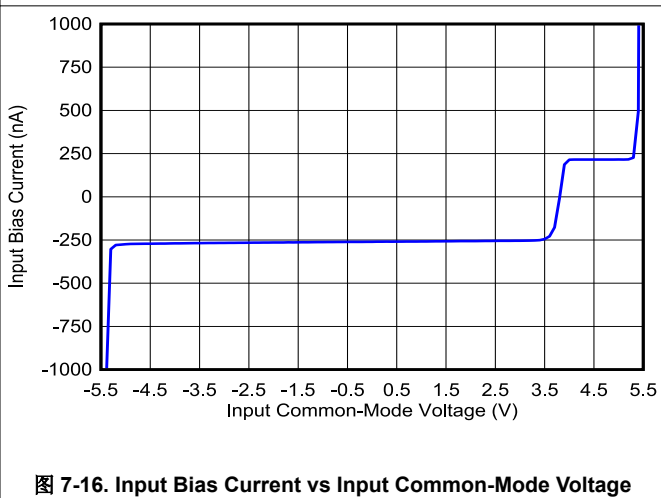
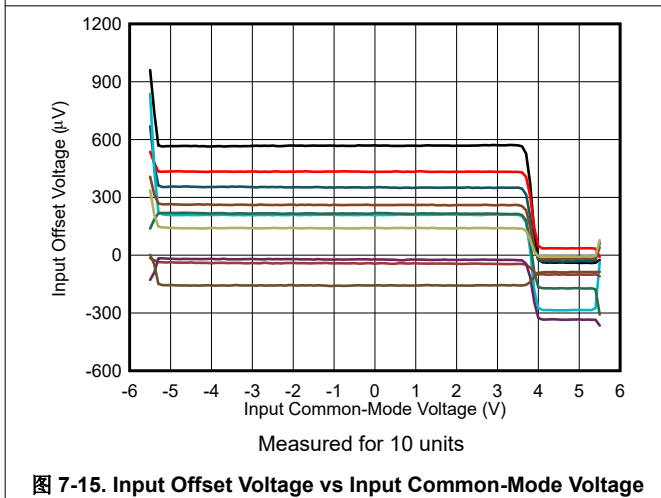
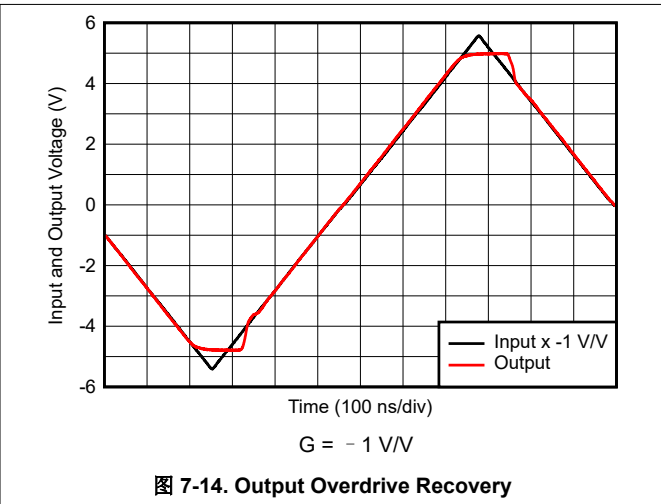
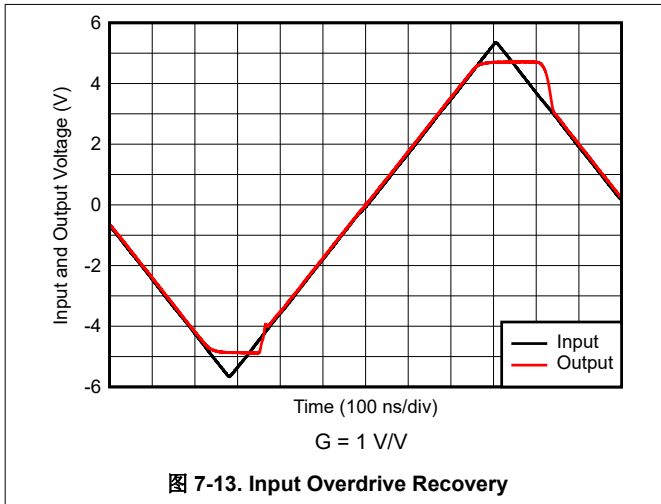
### 7.7 Typical Characteristics: $V_S = \pm 5\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)



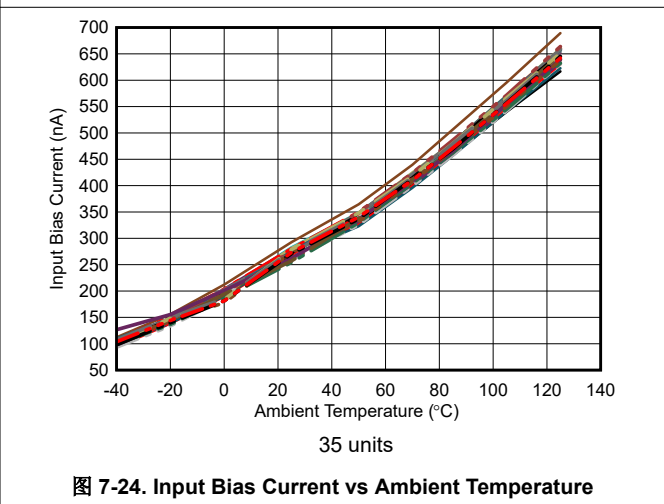
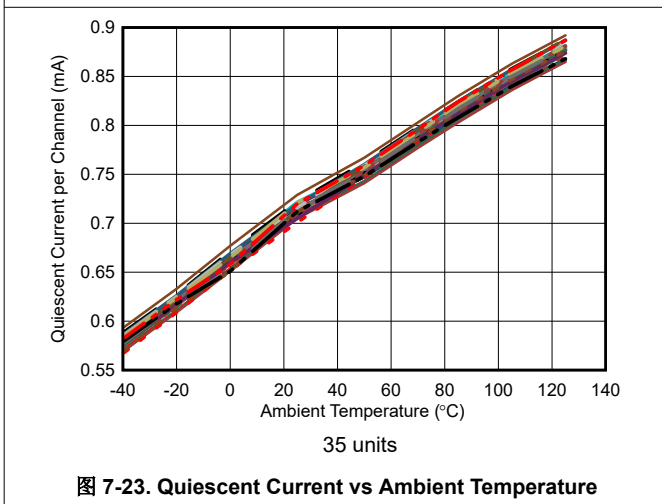
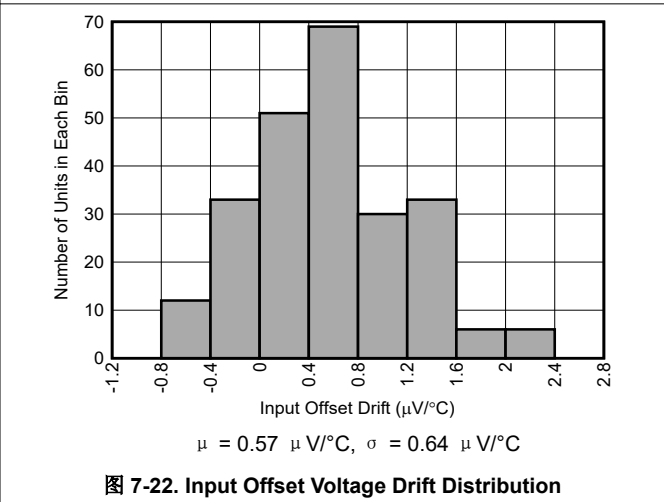
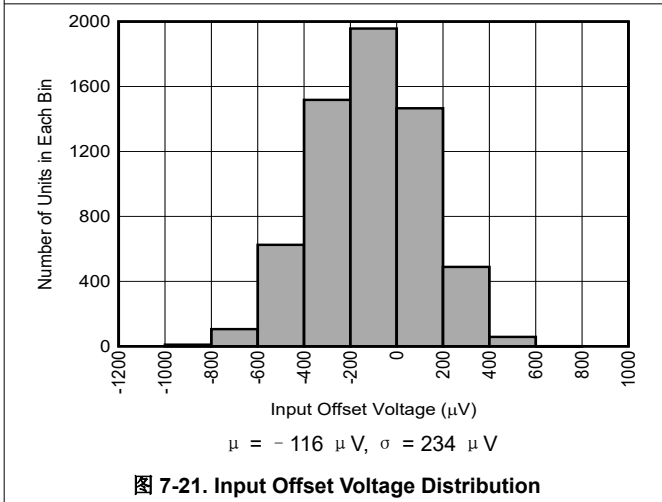
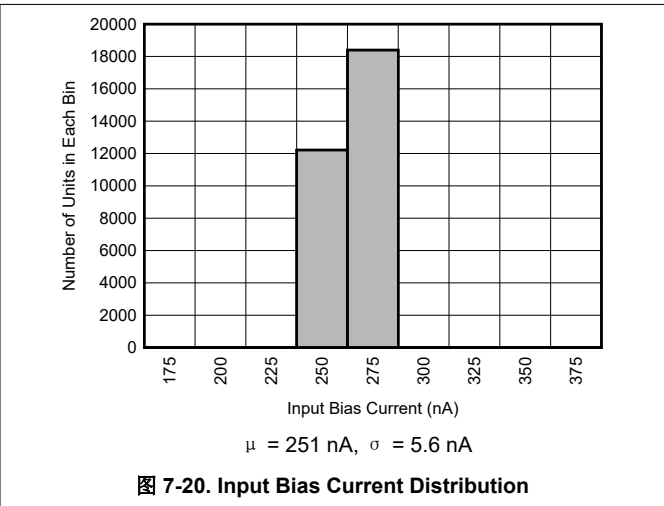
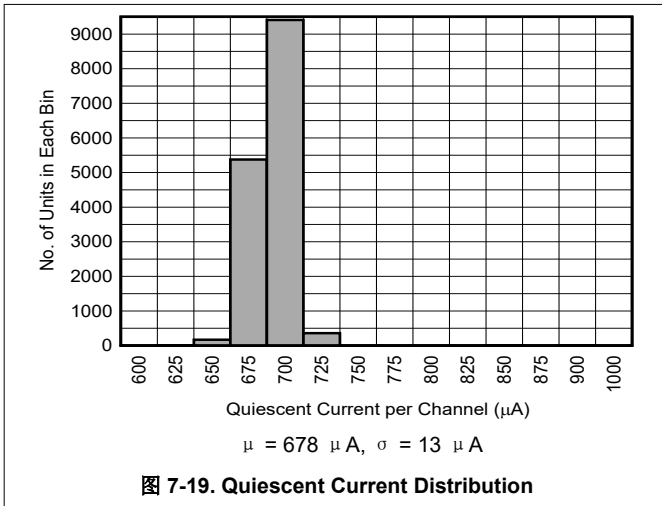
### 7.7 Typical Characteristics: $V_S = \pm 5\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)



### 7.7 Typical Characteristics: $V_S = \pm 5\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)



### 7.7 Typical Characteristics: $V_S = \pm 5\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \cong 25^\circ\text{C}$  (unless otherwise noted)

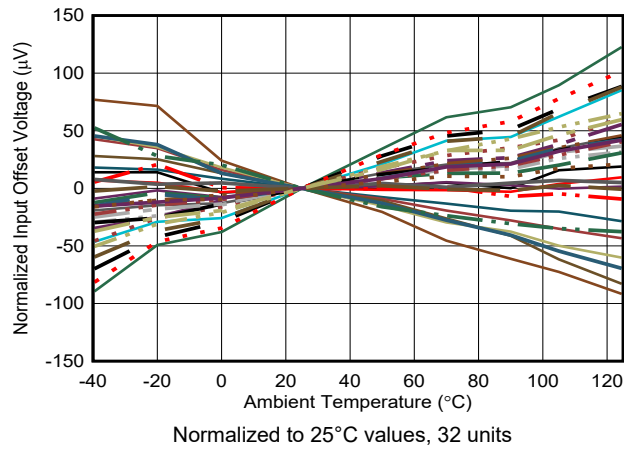
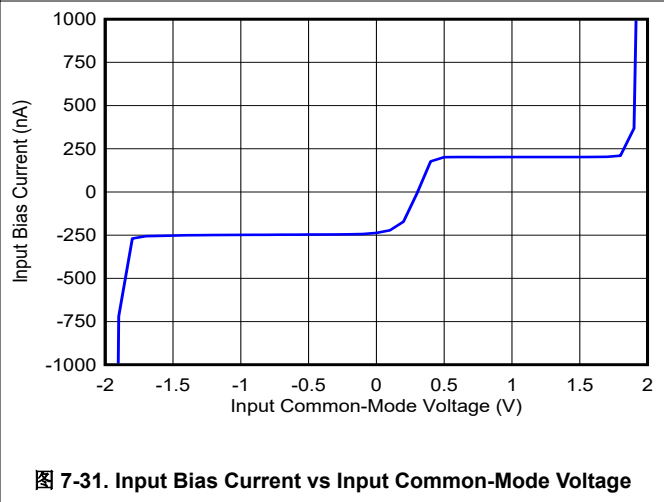
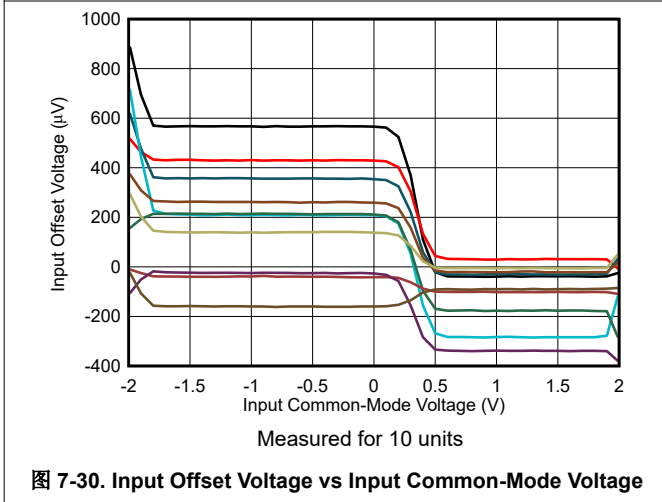
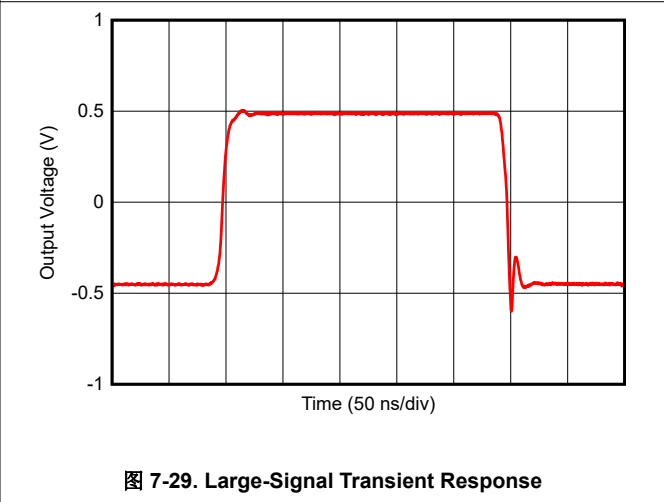
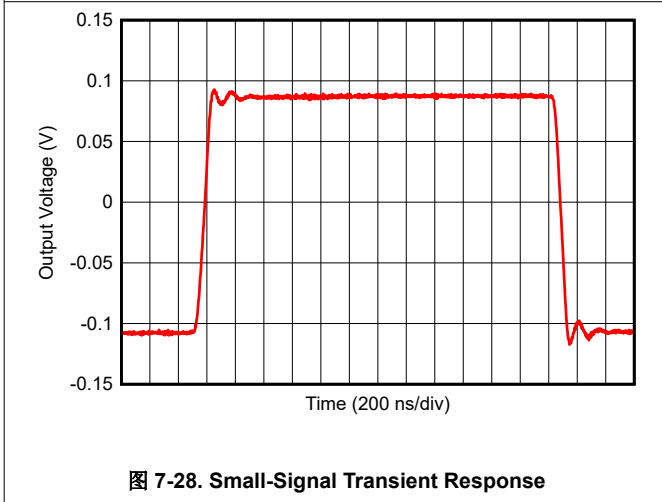
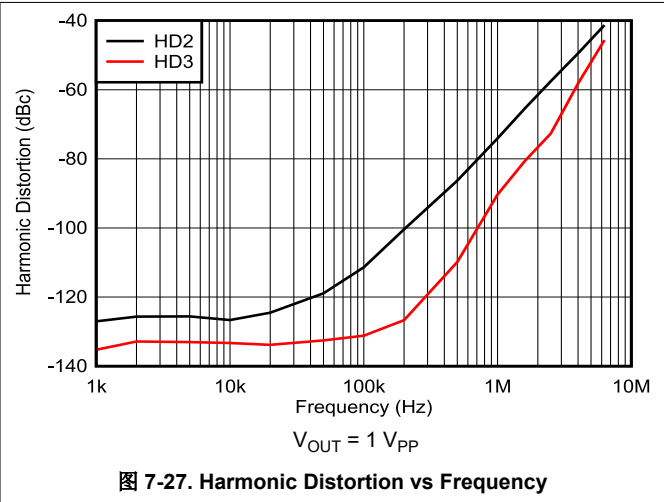
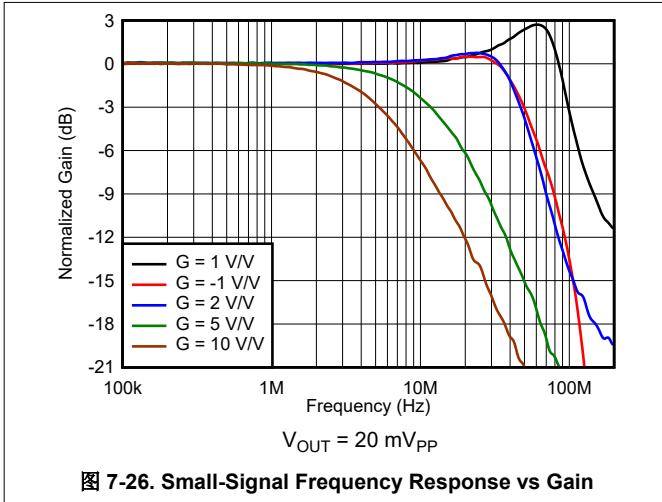


图 7-25. Input Offset Voltage vs Ambient Temperature

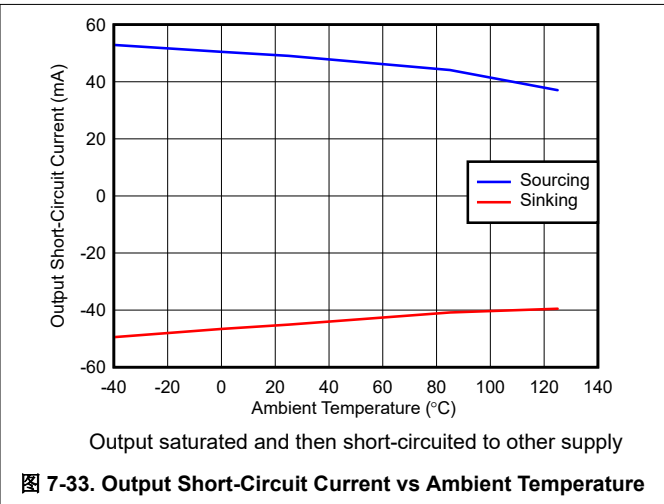
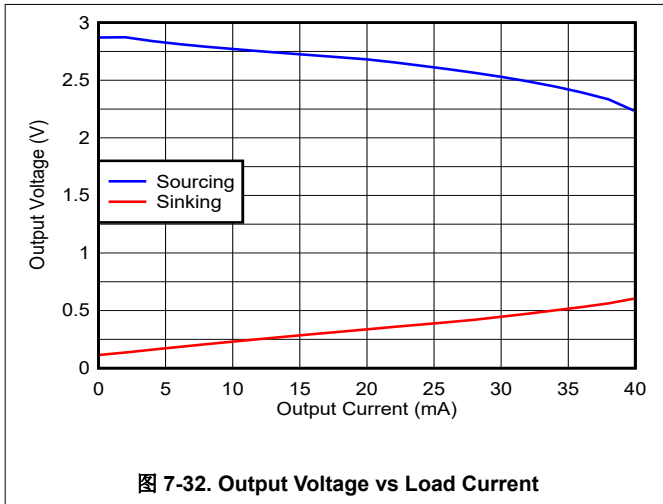
### 7.8 Typical Characteristics: $V_S = 3\text{ V}$

at  $V_{S+} = 3\text{ V}$ ,  $V_{S-} = 0\text{ V}$ ,  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  connected to  $1\text{ V}$ , input and output  $V_{CM} = 1\text{ V}$ , and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)



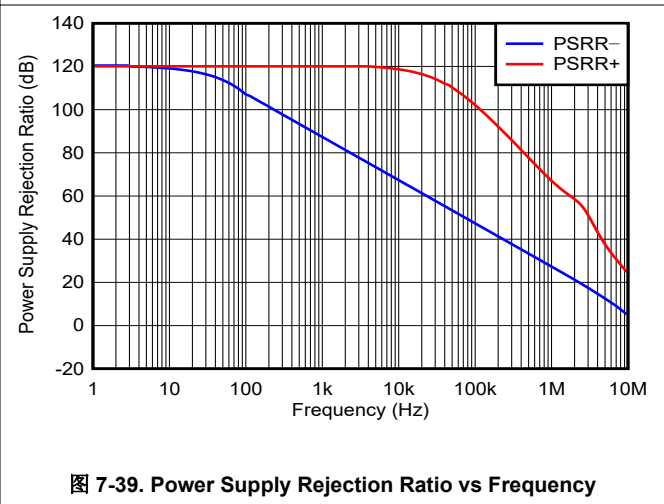
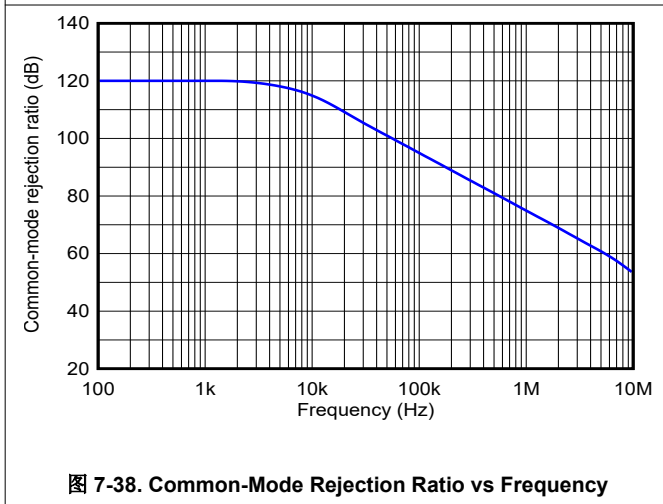
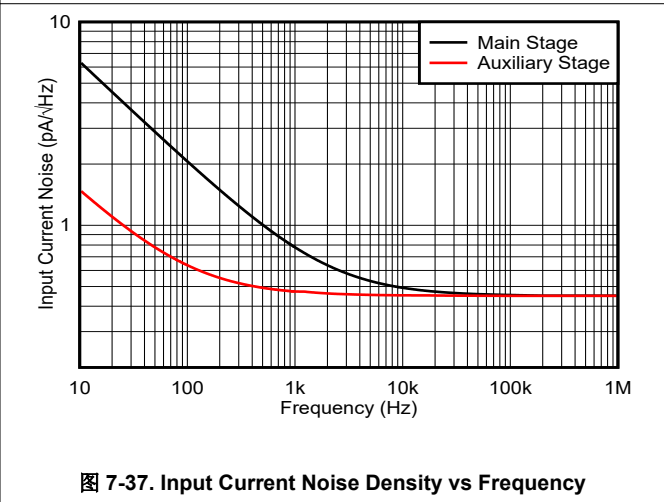
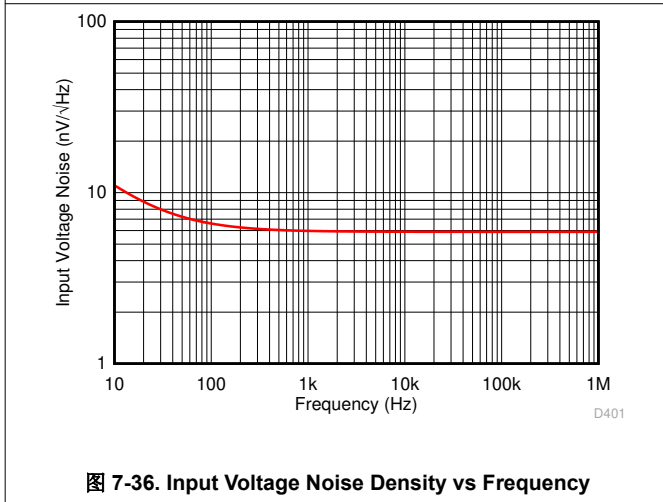
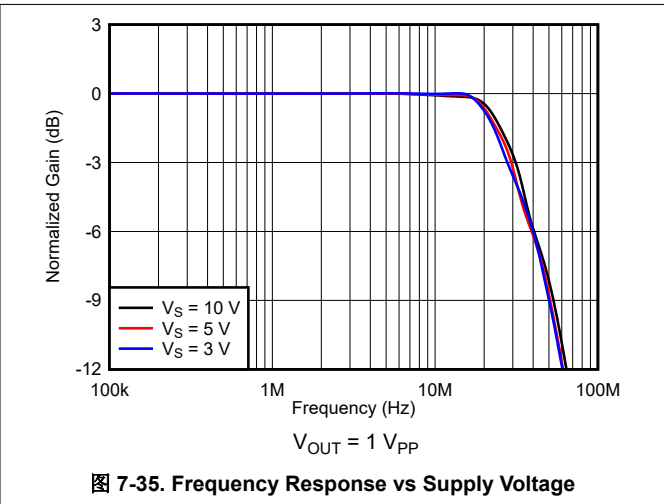
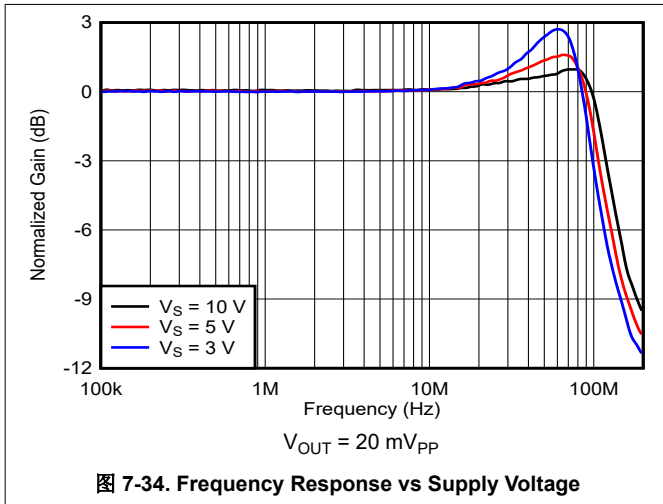
### 7.8 Typical Characteristics: $V_S = 3\text{ V}$ (continued)

at  $V_{S+} = 3\text{ V}$ ,  $V_{S-} = 0\text{ V}$ ,  $G = 1\text{ V/V}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  connected to  $1\text{ V}$ , input and output  $V_{CM} = 1\text{ V}$ , and  $T_A \cong 25^\circ\text{C}$  (unless otherwise noted)



### 7.9 Typical Characteristics: $V_S = 3\text{ V to }10\text{ V}$

at  $G = 1\text{ V/V}$ ,  $V_{OUT} = 2\text{ V}_{PP}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)



### 7.9 Typical Characteristics: $V_S = 3\text{ V to }10\text{ V}$ (continued)

at  $G = 1\text{ V/V}$ ,  $V_{OUT} = 2\text{ V}_{PP}$ ,  $R_F = 0\ \Omega$  for  $G = 1\text{ V/V}$ , otherwise  $R_F = 1\text{ k}\Omega$  for other gains,  $C_L = 1\text{ pF}$ ,  $R_L = 2\text{ k}\Omega$  referenced to mid-supply, input and output referenced to mid-supply, and  $T_A \approx 25^\circ\text{C}$  (unless otherwise noted)

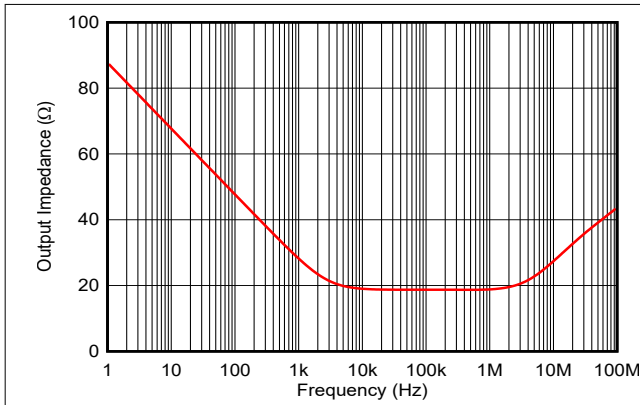


图 7-40. Open-Loop Output Impedance vs Frequency

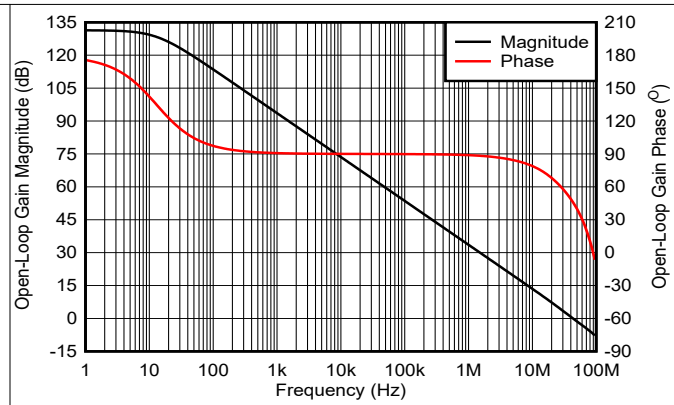


图 7-41. Open-Loop Gain and Phase vs Frequency

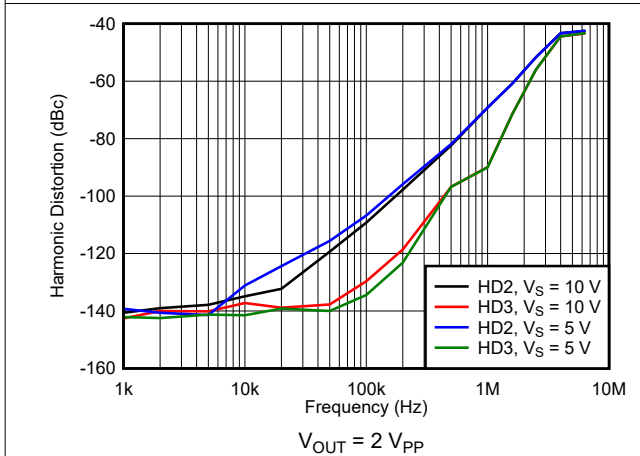


图 7-42. Harmonic Distortion vs Supply Voltage

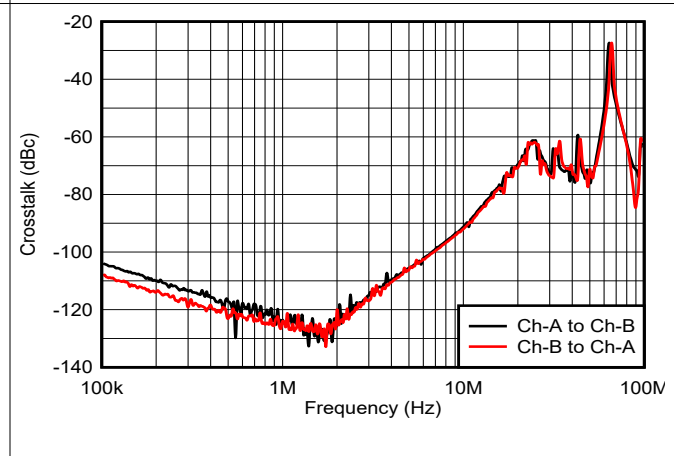


图 7-43. Crosstalk vs Frequency



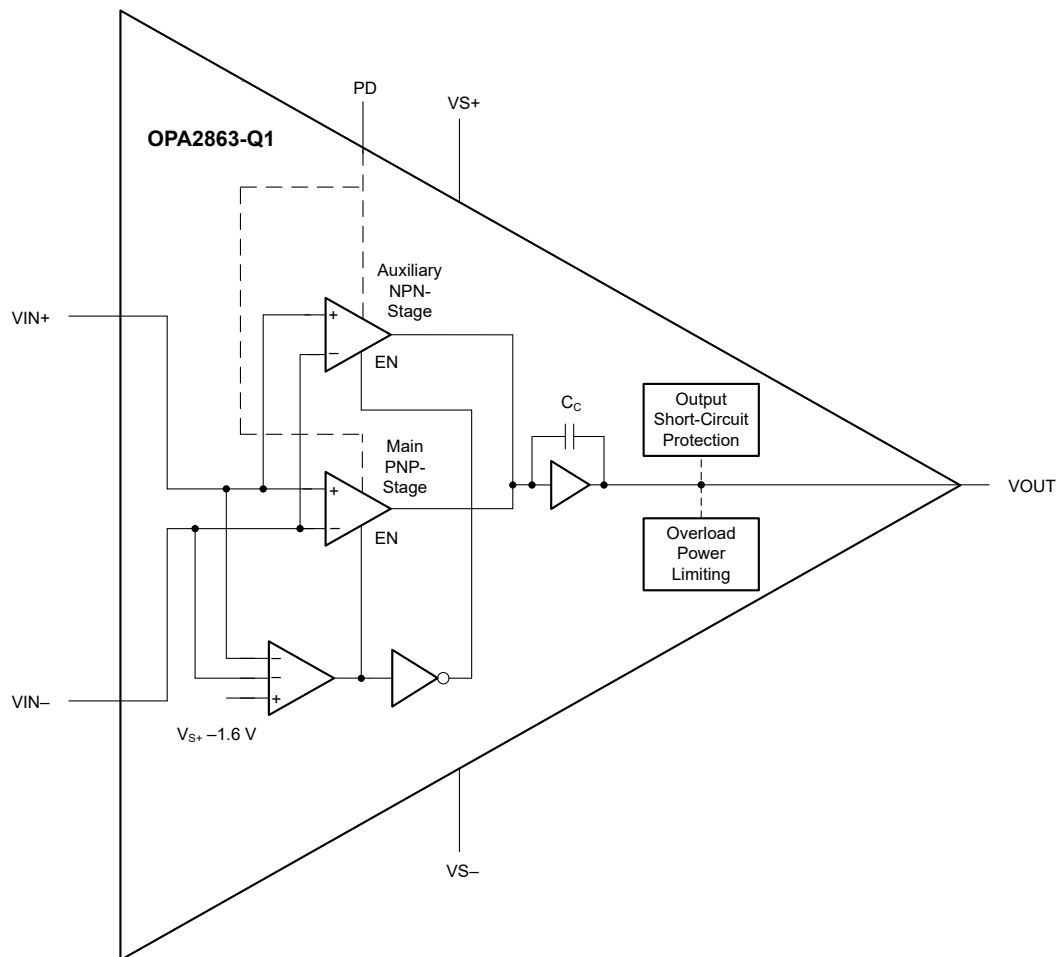
## 8 Detailed Description

### 8.1 Overview

The OPA2863-Q1 is a low-power, 50-MHz, rail-to-rail input and output (RRIO), bipolar, voltage-feedback operational amplifier with a voltage noise density of 5.9 nV/√Hz and 1/f noise corner at 25 Hz. The OPA2863-Q1 works with a wide-supply voltage range of 2.7 V to 12.6 V, and consume only 700 μA quiescent current. The OPA2863-Q1 operates with a 2.7 V supply, is RRIO capable, consumes low-power, which makes this a great amplifier for 3.3-V or lower-voltage applications that require excellent ac performance. The main and auxiliary input stages of the amplifier are matched for gain bandwidth product (GBW), noise, and offset voltage and designed for applications that require wide dynamic input range and good SNR.

The device includes an overload power limit feature which limits the increase in quiescent current with overdriven and saturated outputs to either of the supply rails. For more details of this overload power limit feature, see [节 8.3.2.1](#). The output of the amplifier is protected against short-circuit fault conditions.

### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Input Stage

The OPA2863-Q1 includes a rail-to-rail input stage. The main stage differential pair using PNP bipolar transistors operates for common-mode input voltages from  $V_{S-} - 0.2\text{ V}$  to  $V_{S+} - 1.6\text{ V}$ . The amplifier inputs transition into the auxiliary stage using NPN transistors for common-mode input voltages from  $V_{S+} - 1.6\text{ V}$  till  $V_{S+} + 0.2\text{ V}$ . The PNP and NPN input stages offer a gain-bandwidth product of 50 MHz and a voltage noise density of 5.9 nV/√Hz. The offset voltage for the two input stages is matched to lie within the device specifications. The auxiliary NPN input stage does not use the slew-boost circuit during large-signal transient response. The input bias current for the PNP and NPN input stages is opposite in polarity, which adds an additional offset based on the values of the gain-setting and feedback resistors. A common-mode input voltage transition between these input stages causes a crossover distortion that must be considered in high-frequency applications requiring excellent linearity. Limit the common-mode input voltage to  $V_{S+} - 1.6\text{ V}$  (maximum) for main-stage operation across process and ambient temperature.

The OPA2863-Q1 is a bipolar amplifier; therefore, the two inputs are protected with antiparallel back-to-back diodes between them, which limits the maximum input differential voltage to 1 V. The amplifier is slew limited, and the two inputs are pulled apart up to 1 V when the antiparallel diodes begin to conduct in very fast input or output transient conditions. Make sure to use gain-setting and feedback resistors large enough to limit the current through these diodes in such conditions.

### 8.3.2 Output Stage

The OPA2863-Q1 features a rail-to-rail output stage with possible signal swing from  $V_{S-} + 0.2\text{ V}$  to  $V_{S+} - 0.2\text{ V}$ . Violating the output headroom to either of the supplies causes output signal clipping and introduces distortion.

The OPA2863-Q1 integrates an output short-circuit protection circuit, which makes the device rugged for use in real-world applications.

#### 8.3.2.1 Overload Power Limit

The OPA2863-Q1 includes overload power limiting that limits the increase in device quiescent current with output saturated to either of the supplies. Typically, when an amplifier output saturates, the two inputs are pulled apart, which can enable the slew-boost circuit. The input differential voltage is an error voltage in negative feedback that the amplifier core nullifies by engaging the slew-boost circuit and driving the output stage deeper into saturation. After the input to an amplifier attains a value large enough to saturate the output, any further increase in this input excitation results in a finite input differential voltage. As the output stage transistor is pushed deeper into saturation, the base-to-collector current gain ( $h_{FE}$ ) drops with an increase in the base and collector current, and an increase in the device quiescent current. This increase in quiescent current can cause a catastrophic failure in multichannel, high-gain, high-density front-end designs, and reduce operating lifetime in portable, battery-powered systems.

The OPA2863-Q1 overload power limiting includes an intelligent output saturation-detection circuit that limits the device quiescent current to 2.2-mA per channel under dc overload conditions. This increase in quiescent current is smaller with ac input or output and output saturation duration for only a fraction of the overall signal time period. 表 8-1 compares the increase in quiescent current with 50-mV input overdrive for OPA2863-Q1 and other voltage-feedback amplifiers without overload power limit.

表 8-1. Quiescent Current with Saturated Outputs

DEVICE	INPUT DIFFERENTIAL VOLTAGE	QUIESCENT CURRENT DURING OVERLOAD	INCREASE IN $I_Q$ FROM STEADY-STATE CONDITION
OPA2863-Q1 with overload power limit	50 mV	1.1 mA	1.57 ×
Competitor amplifier without overload power limit	50 mV	1.96 mA	3.43 ×

### 8.3.3 ESD Protection

图 8-1 shows that all device pins are protected with internal ESD protection diodes to the power supplies. These diodes provide moderate protection to input overdrive voltages greater than the supplies. The protection diodes typically support 10-mA continuous input and output currents. Use series current limiting resistors if input voltages exceeding the supply voltages occur at the amplifier inputs, which makes sure that the current through the ESD diodes remains within the rated value. OPA2863-Q1 is a bipolar amplifier; therefore, the two inputs are protected with antiparallel, back-to-back diodes between the inputs that limits the maximum input differential voltage to approximately 1 V. Make sure to use gain-setting and feedback resistors large enough to limit the current through these diodes in fast slewing conditions.

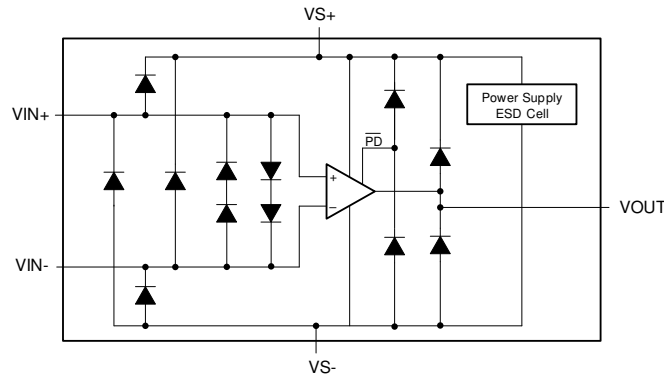


图 8-1. Internal ESD Protection

### 8.4 Device Functional Modes

The OPAx863-Q1 is operational with a supply voltage greater than 2.7 V ( $\pm 1.35$  V). The maximum recommended supply voltage is 12.6 V ( $\pm 6.3$  V). The OPAx863-Q1 can be used with unipolar, bipolar or asymmetric supplies.

## 9 Application and Implementation

### 备注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

### 9.1 Application Information

The OPA2863-Q1 is a classic voltage-feedback amplifier with two high-impedance inputs and a low-impedance output. This device has a GBW of 50 MHz, 5.9 nV/√Hz of noise, RRIO capability, and precision performance, consuming only 700 μA quiescent current per channel. These features make the OPA2863-Q1 an excellent choice for use in low-side current sensing, ADC input driver, and reference buffering with fast settling, buffers, high gain and filter circuits. The overload power limit makes the OPA2863-Q1 truly low-power in high-gain, multichannel systems, limiting any increase in quiescent current during output overload conditions.

### 9.2 Typical Applications

#### 9.2.1 Low-Side Current Sensing

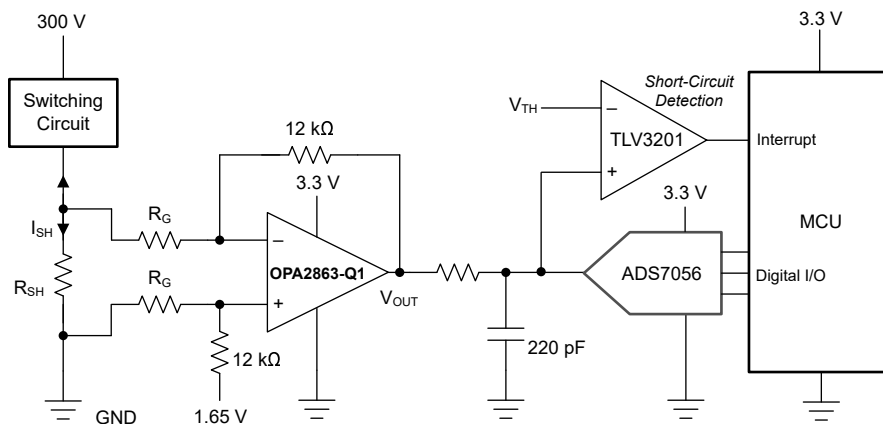


图 9-1. Low-Side Current Sensing in Power Converters

Power converters use current-mode feedback control for excellent transient response and multiphase load sharing. Inverter stages control the phase currents for torque control in motor drives. As a result of the simplicity and low-cost, many of these topologies use difference-amplifier-based, low-side current sensing. 图 9-1 shows the use of the OPA2863-Q1 in a difference amplifier circuit for low-side current sensing.

#### 9.2.1.1 Design Requirements

表 9-1. Design Requirements

PARAMETER	DESIGN REQUIREMENT
Shunt resistor	10 mΩ
Input current	15 A <sub>PP</sub>
Output voltage	3 V <sub>PP</sub>
Switching frequency	50 kHz
Data acquisition	1 MSPS with 0.1% accuracy
Input voltage due to ground bounce	10 V <sub>pk</sub>

### 9.2.1.2 Detailed Design Procedure

In a difference amplifier circuit, the output voltage is given by:

$$V_0 = \frac{R_F}{R_G} I_{SH} R_{SH} + V_{REF} \quad (1)$$

For lowest system noise, small values of  $R_F$  and  $R_G$  are preferred. The smallest value of  $R_G$  is limited by the input transient voltage (10 V here) seen by the circuit, and is given by:

$$R_G = \frac{V_{IN(max)} - V_D - V_S}{I_D(max)} \quad (2)$$

where

- $V_{IN(maximum)}$  is the maximum input transient voltage seen by the circuit
- $V_D$  is the forward voltage drop of ESD diodes at the amplifier input
- $I_{D(maximum)}$  is the maximum current rating of the ESD diodes at the amplifier input

For a difference amplifier gain of 20 V/V, an  $R_F$  of 12 k $\Omega$  and  $R_G$  of 600  $\Omega$  are used. With a clock frequency of 40 MHz and ADS7056 sampling at 1 MSPS, the available acquisition time for amplifier output settling is 550 ns. [表 9-1](#) shows the simulation results for the circuit in [图 9-1](#). The worst-case peak-to-peak input transient condition is simulated. The output of the OPA2863-Q1 settles to within 0.1% accuracy within 543 ns. If using a slower clock frequency with the ADC is desired, then the acquisition time reduces with the same sampling rate, which degrades measurement accuracy. Alternatively, the sampling rate can be reduced to recover the required acquisition time and 0.1% accuracy.

### 9.2.1.3 Application Curve

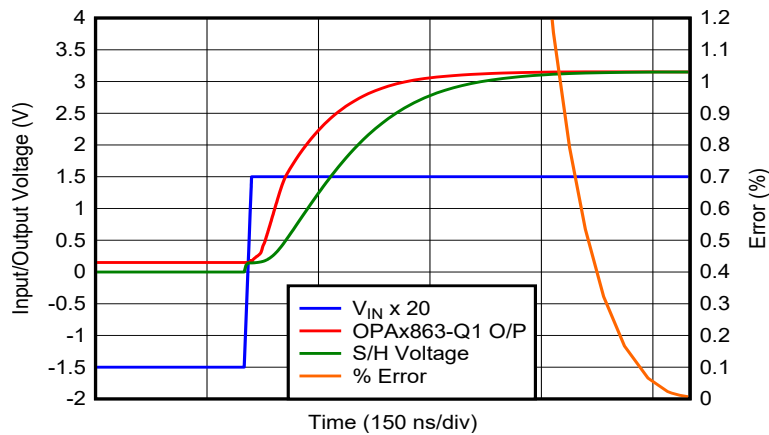


图 9-2. 0.1% Settling Performance

## 9.2.2 Front-End Gain and Filtering

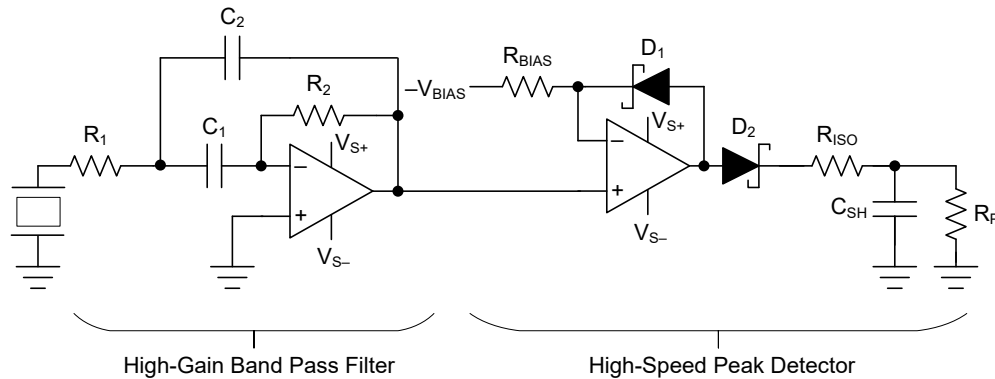


图 9-3. High-Gain Narrow Bandpass Filter and Peak Detector Circuit

Ultrasonic signaling is used for proximity and obstacle detection, level sensing, sonars, and so forth. Such signal chains detect the amplitude of received ultrasonic signal at a particular center frequency. 图 9-3 shows a high-gain narrow bandpass filter and peak detector circuit using the OPA2863-Q1. The signal at the frequency of interest is filtered out, gained, and peak detected to report the amplitude at the output of this circuit. The phase information is lost in this circuit. The OPA2863-Q1 is used with the 50-MHz GBW to add a single-stage gain, and the peak detection capability is easily made with the RRIO capability of these amplifiers.

## 9.3 Power Supply Recommendations

The OPA2863-Q1 is intended to operate on supplies ranging from 2.7 V to 12.6 V. The OPA2863-Q1 operates on single-sided supplies, split and balanced bipolar supplies, or unbalanced bipolar supplies. Operating from a single supply has numerous advantages. The dc errors, due to the  $\psi$ -PSRR term, can be minimized with the negative supply at ground. Typically, ac performance improves slightly at 10-V operation with minimal increase in supply current. Minimize the distance ( $< 0.1$  in) from the power supply pins to high-frequency, 0.01- $\mu$ F decoupling capacitors. A larger capacitor (2.2  $\mu$ F typical) is used along with a high-frequency, 0.01- $\mu$ F supply-decoupling capacitor at the device supply pins. Only the positive supply has these capacitors for single-supply operation. Use these capacitors from each supply to ground when a split-supply is used. If necessary, place the larger capacitors further from the device and share these capacitors among several devices in the same area of the printed circuit board (PCB). An optional supply decoupling capacitor across the two power supplies (for split-supply operation) reduces second harmonic distortion.

## 9.4 Layout

### 9.4.1 Layout Guidelines

Achieving optimum performance with a high-frequency amplifier (like the OPA2863-Q1) requires careful attention to board layout parasitics and external component types. The [DEM-OPA-SO-2A Demonstration Fixture user's guide](#) can be used as a reference when designing the circuit board. Recommendations that optimize performance include the following:

1. **Minimize parasitic capacitance** to any AC ground for all of the signal I/O pins. Parasitic capacitance on the output and inverting input pins can cause instability—on the noninverting input, parasitic capacitance can react with the source impedance to cause unintentional band-limiting. Open a window around the signal I/O pins in all of the ground and power planes around those pins to reduce unwanted capacitance. Otherwise, ground and power planes must be unbroken elsewhere on the board.
2. **Minimize the distance** (< 0.1 in) from the power-supply pins to high-frequency 0.01- $\mu\text{F}$  decoupling capacitors. Avoid narrow power and ground traces to minimize inductance between the pins and the decoupling capacitors. The power-supply connections must always be decoupled with these capacitors. Larger (2.2- $\mu\text{F}$  to 6.8- $\mu\text{F}$ ) decoupling capacitors, effective at lower frequency, must also be used on the supply pins. These capacitors can be placed somewhat farther from the device and shared among several devices in the same area of the PCB.
3. **Careful selection and placement of external components preserves the high-frequency performance of the OPA2863-Q1.** Resistors must be a low reactance type. Surface-mount resistors work best and allow a tighter overall layout. Other network components, such as noninverting input termination resistors, must also be placed close to the package. Keep resistor values as low as possible and consistent with load-driving considerations. Lowering the resistor values keeps the resistor noise terms low and minimizes the effect of the parasitic capacitance. Lower resistor values, however, increase the dynamic power consumption because  $R_F$  and  $R_G$  become part of the amplifier output load network.

### 9.4.2 Layout Example

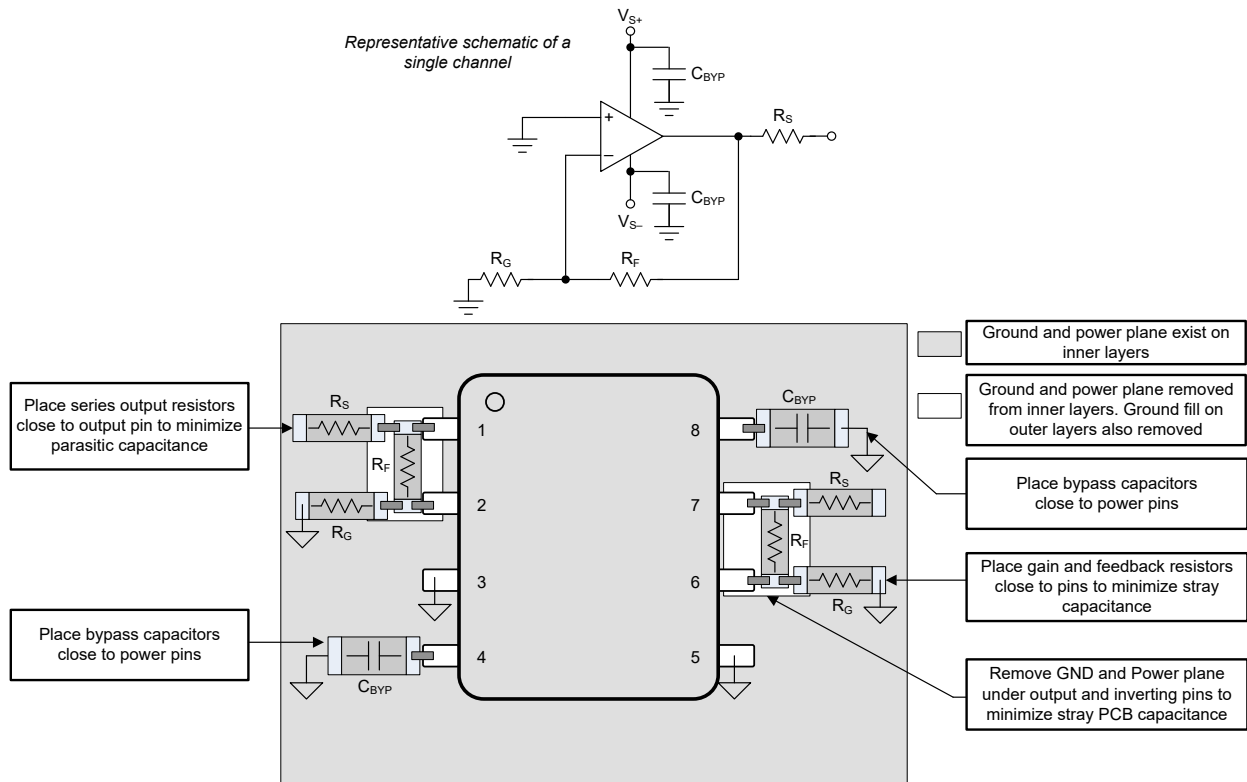


图 9-4. Layout Recommendation for Dual-Channel D Package

## 10 Device and Documentation Support

### 10.1 Documentation Support

#### 10.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [DEM-OPA-SO-2A Demonstration Fixture user's guide](#)
- Texas Instruments, [Single-Supply Op Amp Design Techniques application report](#)

#### 10.2 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](https://www.ti.com) 上的器件产品文件夹。点击 [订阅更新](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

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TI E2E™ [支持论坛](#) 是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

#### 10.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

## 11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
OPA2863QDRQ1	ACTIVE	SOIC	D	8	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	O2863Q	Samples

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

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(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF OPA2863-Q1 :**

- Catalog : [OPA2863](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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